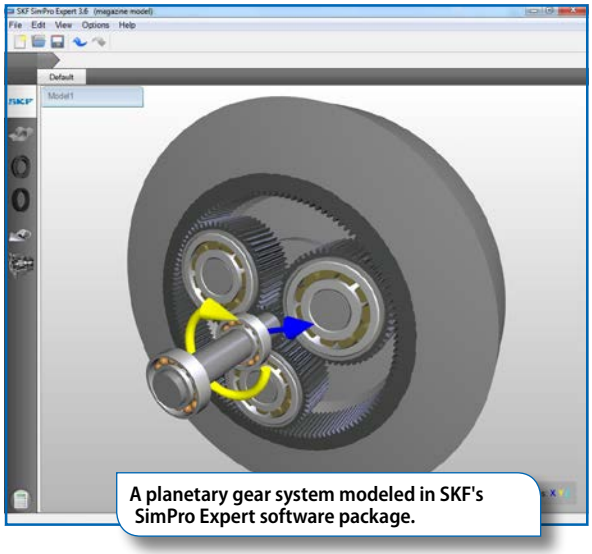
# Getting to Know Your Bearing

## Software Design, Analysis and Calculation Tools Help Solve Today's Engineering Challenges

Matthew Jaster, Senior Editor

I had questions about my bearings. Well, not my bearings per se, but bearings in general. In order to properly discuss temperature, speed, power loss, fatigue life and lubrication in the eyes of the end user, I spent two hours online with Travis Shive, application engineer, industrial division at SKF to see how simulation tools really work in mechanical power transmission applications.



A planetary gear system modeled in SKF's SimPro Expert software package.

We eased into the engineering with a bearing selection tool, first. Very cut and dry. Enter the data you need, select the bearing that best fits your requirements, rinse and repeat. *Bearing Select* would eventually evolve into the company's *SimPro Quick* software, our second stop on the guided tour.

SKF *SimPro Quick* is a single-shaft bearing simulation software developed to quickly evaluate the design of bearing arrangements and their field performance, based on relevant application requirements and conditions. The tool aims to provide customers with more engineering knowledge and autonomy to accelerate the design process. This was followed by a short tutorial on SKF *Beast*, an internal software program that does a little bit of everything, especially the more complicated bearing simulation scenarios.

The point of this online exercise was to get a sense of the storytelling going on inside the bearing.

While I deal in sentence structure, words and phrases, engineers at SKF, Schaeffler, Timken, Romax and KISSsoft have their own unique way to tell a story. They utilize computer screens, simulation models and field data to make it easier and more efficient for design engineers to make informed decisions regarding their applications.

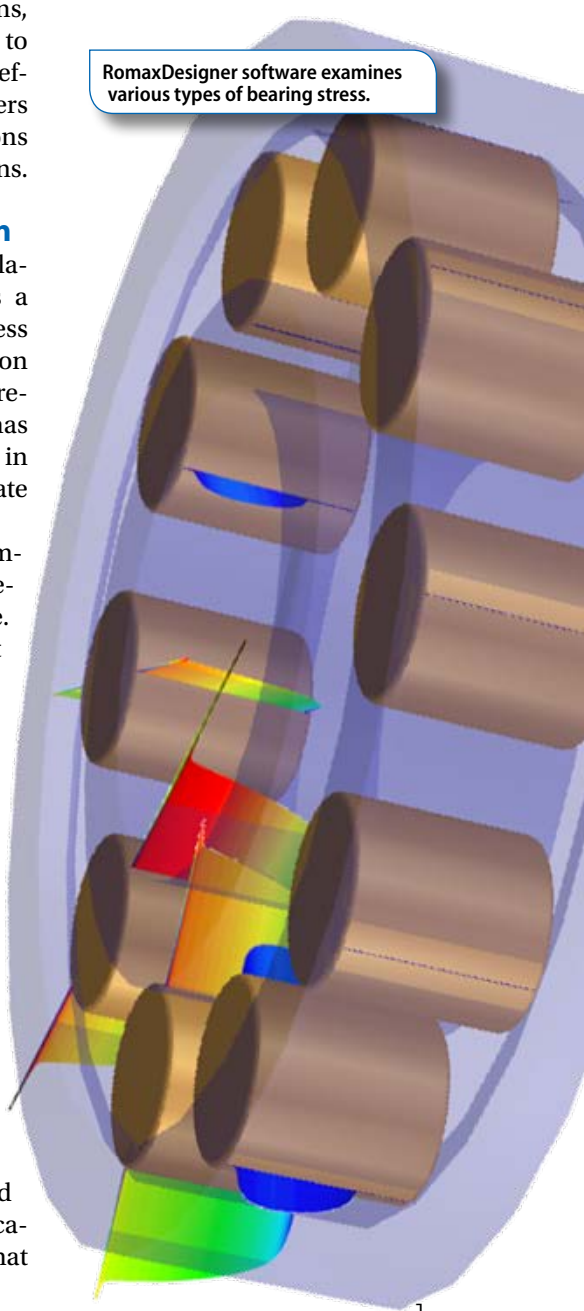
### Instant Gratification

In the past, bearing calculation and simulation was a particularly lengthy process (it still can be depending on the programming requirements), but technology has come a long, long way in giving engineers immediate results and feedback.

"The immediacy is so important today for the design engineer," says Shive. "End users can build their design at their location and have something up and running right away. Here's my shaft. Here are my bearings. What are my results? This is one of the key elements in bearing design today, the ability to make a decision immediately based on the simulation."

Just making the CAD drawings available is a significant step in the right direction, according to Brian Ray, chief engineer — industrial and application engineering at Timken. "Our CAD downloads are just one example of how we are sharing our bearing knowledge to help customers effectively select and design our products to their applications. It also provides insight on what customers are looking for and what information to add to our website in the future," Ray said.

Carlo Bianco, global bearing team leader at Romax, said that in the challenging loading environment of today's transmissions, capturing potential bearing issues early in the development process is a major benefit. This



RomaxDesigner software examines various types of bearing stress.

has been the driver behind key developments in *RomaxDesigner (R17*).

"*R17* includes the rapid and accurate prediction of bearing roller contact and edge stresses, improved simulation of the effect of variable roller rib contact height and new, predictive, hydrodynamic simulation of journal bearings to optimize geometry within a full system model," said Bianco.

These are all features and capabilities that give design engineers more options to work with.

The latest KISSsoft release features a bearing design tool (fine sizing) where various parameters can be altered (eg. conformity of ring raceways, size and pitch diameter of rolling bodies and so on) and their influence on the bearing performance can be investigated.

"An additional feature is the consideration of the elasticity of the rings. Existing calculation methods always assume fully rigid rings, however modern gearbox designs feature increased power density and lower weight/dimensions, thus leading to ring elastic behavior which can't be neglected," said Stefan Beermann, CEO at KISSsoft.

For Schaeffler, the software tools continue to evolve and the company examines key areas that affect how their customers approach each application. "Complete system analytics of the bearings, gears, shafts, housings or plant carriers can be accounted for in many of these tools by integrating FEA-based stiffness behavior/methods into the simulations," said Scott Hart, manager advanced development, at Schaeffler.

This "systems approach" versus focusing on a single component is the direction this industry is heading, particularly with machine to machine communication and the continuous push for digital manufacturing solutions (more on this later).

"We utilize so many programs today that our customers are learning pretty quickly that there are so many different ways these programs build on each other," Shive said. "If they're having a difficult time with a design they can send us the file and we can assist in the process."

## The Industrial Internet of Things

One contributing factor to software tools is the continual push for machine to machine communication whether you call it Industry 4.0, IIoT or digital manufacturing.

The wind industry was driving remote monitoring of bearings a decade ago. The techniques used here are not different from the IIoT approach. "For the bearing software itself the influence is not very large, however, a new possible application of such software is the prediction of remaining lifetime for a bearing based on the load history as measured during service," Beermann said.

IIoT is influencing the use of simulation tools by using the tools to analyze collected data to predict remaining life or assess potential damage that may have occurred during operation as well as determine what type of maintenance is required, according to Hart.

"At what level does the analysis occur, in the cloud based on data transferred from the machine or within the machines own data collection? This still needs to be reviewed and optimized when deciding how best to match simulation methods with available data, data transfer rates, etc.," Hart added.

Ray knows it is important to deliver on Timken's commitment to its customers both physically and digitally. "We are working to provide a digitized option for every customer touch point. We have e-commerce capabilities for distributors and end-user customers. Through our website and social media channels, we are reaching individual customers, end users and distributors to aid in product selection and problem solving. Now, we are converting the customer information we are gathering to better understand what products are needed and where, and what problems need to be solved," Ray said.

At Romax, IIoT is very significant for the condition monitoring and prediction of future life for bearings. "In recent times, through our InSight brand of Internet-based sensors and monitoring systems, we have been able to detect faults and forecast the remaining useful life of wind turbine gearboxes and mainshaft bearings. This is vital for implementing optimized operations and maintenance strategies as well as effective financial planning. The methods have already brought huge savings to the wind turbine industry, due to the high cost of maintenance in challenging environments," said Bianco.

Earlier this year Romax formed InSight Analytics Solutions, a new joint venture company with Castrol to exclusively take this technology forward, scale it globally and expand to other industries. Romax will continue to work with InSight to jointly develop new areas of technology, particularly around model based prognostics and beyond current IIoT and towards the future of the "Digital Twin" (a model-based representation of the physical, 'as manufactured' parts which are created at time of manufacture and persist for the lifetime of that part or system).

## The Age of Mobility

In this age of instant gratification, mobile tools are helping engineers get field data quicker and more efficiently than ever. Many of the software tools and apps available today can be downloaded right to your smartphone or tablet, accessed right on an oil rig, or sent to a desktop computer for evaluation. In a sense, the computer lab of old has gone completely mobile.

"This is a quick and easy way to offer information to our customers in the field," Shive said. "It's better than lugging around a clunky, laptop onsite and it's nice when the device just fits in your pocket."

Many bearing software tools can be downloaded directly to your smartphone, according to Timken.

Mobile devices enable a level of productivity that was not easy to accomplish in the past, according to Ioannis Kaliakatsos, software development at KISSsoft. "Huge amounts of data (especially reference documentation and manuals) are easy to carry around, detailed calculations are easy to perform on-the-go, and communication with the main company intranet is easy, and thus critical decisions can be made."

Hart said that the computing power in today's mobile devices enables many of the initial simple simulations related to traditional fatigue life, lube life, deflections, or operating temps based on simple values of torque, load, speed and temp to be run on site in the hands of the customer. "This allows for a faster assessment of the variables considered without having to transfer large amounts of data to the cloud or wait on a large simulation to be created," Hart added.

Romax sees the future of engineering software to be firmly in the cloud. As the industry moves towards democratization, increased integration between software tools will be necessary to allow a more streamlined process, and more efficient engineering decision making.

"The key to unlocking such a flexible, open eco-system, is to have flexible products which allow users to quickly and easily collaborate with each other. For us, this means cloud — software that is easily and conveniently accessible, fast and on any device. There are many ways in which this could materialize — cloud CAE software may offer full simulation, simply model visualization, or results' generation and sharing," added Bianco.

KISSsoft's latest release includes useful bearing data for engineers.

## Tomorrow's To-Do List

So what happens next? It's amazing to think about how much this technology has changed recently, we asked each company to give us a hint at things to come. Beermann at KISSsoft started the conversation with the gearbox:

On a gearbox level bearings are often the critical components nowadays, he said. Selecting the right bearings for a specific application needs modelling of the complete environment, which means the system of a relevant components such as shafts, gears and so on. On the other hand, the mechanical behavior of the bearings has a significant influence on the performance of the gears.

"So, bearing software as a standalone tool will vanish to a certain degree, and the calculation will be integrated into the system calculation. For efficiency and noise, the calculation methods will be improved. And if the bearing standards follow the path the gear standards were taking, more and more specialized methods will be developed for specific failure modes like pitting, micro pitting or cracks," Beermann said.

SKF will possibly focus on consolidating its software offerings into a single package in the future, according to Shieve. "I see this potentially down the road, software tools that adapt to the changing needs of the industry by bringing all the programs together in one platform," Shieve said.

Romax perceives that the evolution of bearing calculation software will be driven by three major factors: the changing demands of the industry and subsequent requirements to investigate novel transmissions; more powerful computing which will enable a wider audience to perform more advanced analysis; and the world's leading innovators continuing to develop creative technology.

"As computers become more powerful, and computing devices more mobile, the need for data to be instantly accessible, anywhere, will only become greater. This could include centralized cloud databases, or apps for model visualization or analysis. Driven by the need for fast and collaborative processes, this industry development will enable more convenient collaboration and data sharing, across a range of devices," Bianco said.

Ray agreed, "While it is hard to predict how software and technology will change, we do know our customers want more access to more information, and it needs to be easy to find and to understand. We do know our customers like materials in all forms — printed, online and interactive. We are now evaluating cloud-based applications to bring the right tools to individuals, end users and distributors," Ray said.

"I believe that in the future more and more levels of calculation software will be incorporated from the sensor all the way to the cloud to condition/filter the data so that decisions about the life, remaining life, maintenance required/reordering new bearings can be made for a multitude of machines at just the right level for efficient management of the assets," Hart said.

"This will most likely require computing/AI technology being incorporated into a variety of devices (sensors, data collection, data transfer)," he added. **PTE**

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